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A SILVICULTURAL PRESCRIPTION FOR STAND 301.2-03

BERTIE LORD - MEADOW - CAMERON PLANNING UNIT

SULA RANGER DISTRICT

BITTERROOT NATIONAL FOREST

By

David A. Filius

B. S. Michigan State University, 1959

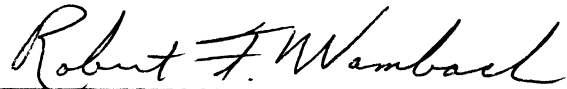
Presented in partial fulfillment of the requirements for the degree of

Master of Forestry

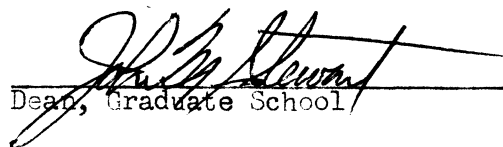
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1976

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## Chapter I

### INTRODUCTION

#### Location.

Stand No. 03 is located in Block 3, Compartment 01, Subcompartment .2, on the Sula Ranger District, Bitterroot National Forest, Ravalli County, Montana. The stand occupies 52 acres in the NE $\frac{1}{4}$ , Section 8, T2N, R18W, MPM and is 18 miles from Sula, Montana, and 30 miles from Darby, Montana, the probable wood product destination. Access off Highway 93 begins at the junction of Rye Creek Road #75, continues east to Road #5778, thence southeast to Blue Mountain, and thence southwest on Road #717. The stand lies above and to the southeast of Road #717 in the headwaters of the Cameron Creek drainage at an elevation of 7,000 feet.

#### History.

Stand 301.2-03 originated from natural regeneration following the 28,000 acre Sleeping Child Burn in August of 1961.

Prior to the burn, the site was unroaded and occupied by a stand of 150-250 year old subalpine fir (Abies lasiocarpa (Hook.) Nutt.), Engelmann spruce (Picea engelmannii Parry), Douglas-fir (Pseudotsuga menziesii var. menziesii), and lodgepole pine (Pinus contorta Dougl.). In the 1920's, much of the lodgepole pine was killed by mountain pine beetle (Dendroctonus ponderosae). During the 30's, 40's, and 50's, helped by persistent and effective fire control, dead bug killed material accumulated until the hot, dry summer of 1961, when lightning ignited a fire on August 4th that quickly reduced the stand to smoking embers and charred snags.

Within weeks of the burn the site was aerially seeded with grasses and clover to prevent soil erosion. In the seasons that followed, Road #717 and several spur roads and incised skid trails were constructed on the site to facilitate salvage logging. Although there is no record of the volume removed, old stumps on this site indicate that the previous unmanaged stand was capable of producing trees up to 22" dbh. Unmerchantable remaining snags show heights of 60-80 feet.

Some cattle use has occurred since the mid-60's, but with successional development is becoming more and more incidental. The residual deadwood has little value except for posts, poles and firewood close to roads.

Essentially the site is not being used by man, and has naturally regenerated to a heavy stand of coniferous seedlings and saplings.

#### Land Management Objectives.

Existing management objectives, though broad and somewhat subjective, encourage timber management on this site, including investments in thinning.

Cameron Creek drainage which was already burned off and roaded, was not part of the controversy associated with unroaded parts of the Bitterroot National Forest and was assigned a low priority for land use planning. The stand is in the Bertie Lord - Meadow - Cameron Planning Unit which is scheduled for environmental analysis in 1976-77.

Until new management direction is developed, the area is broadly covered by the 1967 Sula Ranger District Multiple Use Plan, which places Stand 301.2-03 in the General Forest Zone, Unit 1. This plan notes on Page 7 that, "Thinning lodgepole reproduction in the Sleeping Child Burn

will benefit timber and extend the period of temporary grazing in the lodgepole type." The decision is then made to "Thin as many and as large areas as possible. Permit as much grazing as proper soil and watershed management will allow."

Timber stand stratification made for the Bitterroot 1972 Timber Inventory placed the stand area in the "Standard"<sup>1/</sup> timber stratification.

The stand area is further covered by guidelines in the 1972 Bitterroot Multiple Use Plan, Part I. A basic assumption of that plan on Page 32 states that, "Increases in wood fiber production will depend upon ... c) Investment in cultural practices, such as thinning, to improve stocking levels during the rotation." None of the Coordinating Requirements for Timber on Page 37 of Part I provide guidance specific to young developing stands. Coordinating Requirements for Range, however, specify on Page 39 that, "Conversion of natural cover types, i.e., conifer to grass (etc.), will not be done for the express purpose of increasing livestock forage." (36).

#### Stand Selection Criteria.

This stand represents a large acreage in the Sleeping Child Burn and elsewhere throughout the Sula Ranger District.

The district began release cutting in the dense reproduction as early as 1966. Large investments were made in both hand pulling and chemical thinning, but these efforts were curtailed in 1970. In 1974, release cutting was resumed and this time excess trees were removed with snippers, axes, and chainsaws.

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<sup>1/</sup>Standard is the component of the regulated commercial forest land that can be adequately protected with conventional logging methods and practices.

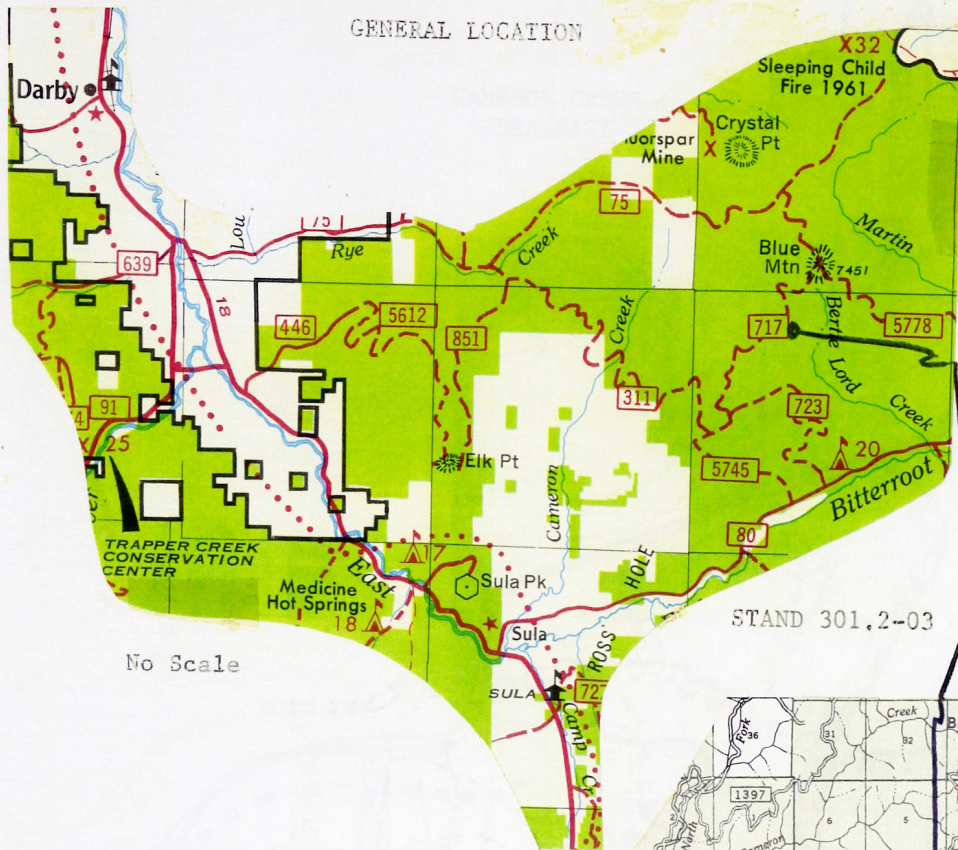


Though these stands have obvious investment opportunities, decisions to make these investments have not been subjected to careful scrutiny.

My objective with this prescription will be to shed light on the degree of management that is justified and assist the forest and district in establishing priorities for expenditure of timber stand improvement funds.

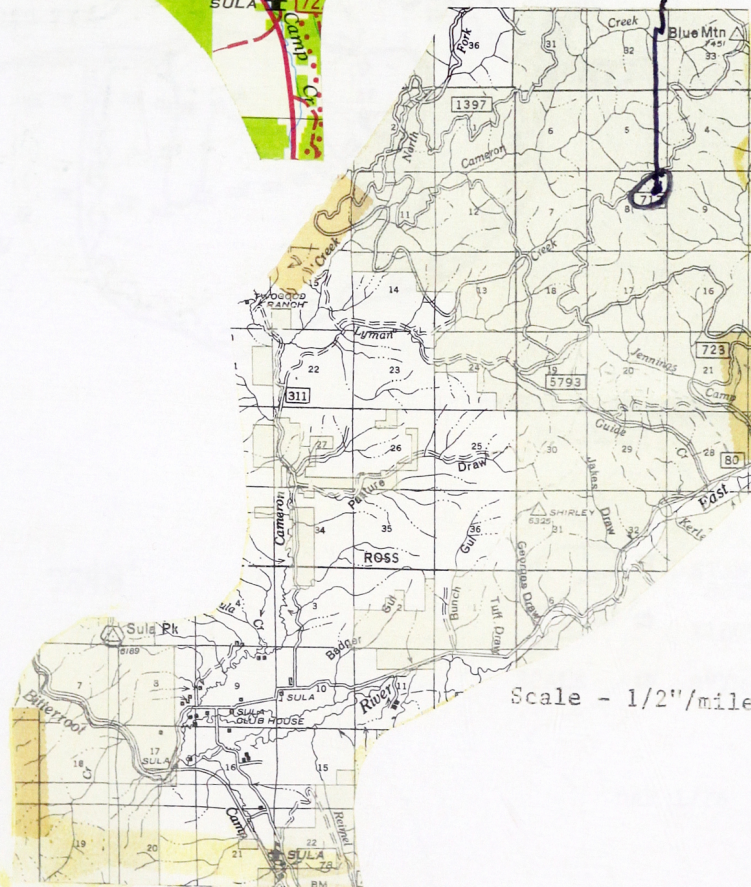
# GENERAL LOCATION

4a



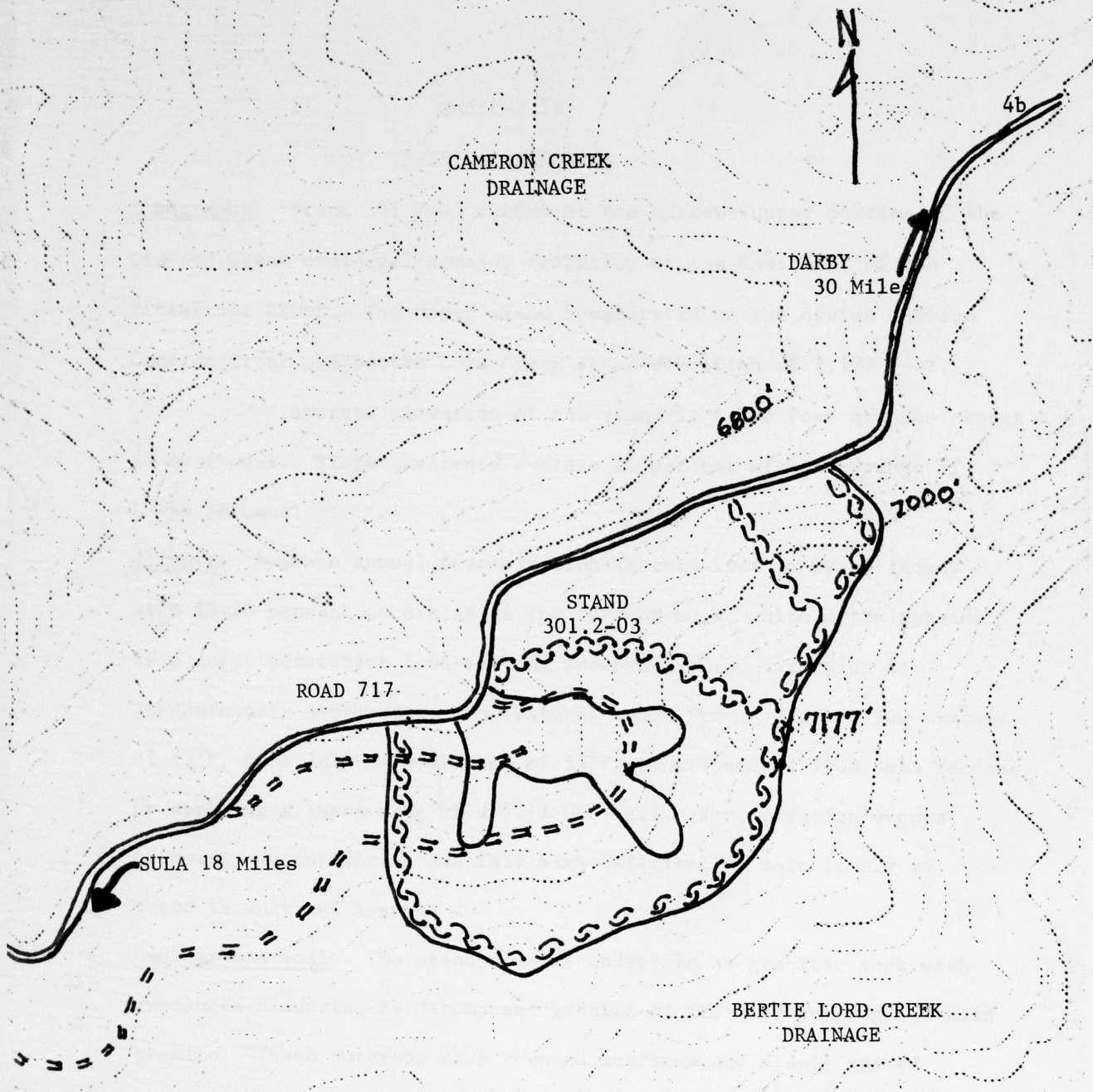
No Scale

STAND 301.2-03



Scale - 1/2"/mile





## Chapter II

### PHYSICAL ELEMENTS

Topography. Stand 301.2-03 occurs at the extreme upper portion of the Cameron Creek drainage, a major tributary of the East Fork of the Bitterroot River. The upper stand boundary is on the divide between Cameron Creek and Bertie Lord Creek at an elevation of 7,177 feet.

Average elevation of the stand is 6,900 feet and the aspect is northwest. Slope gradients average 25 percent within a range of 10-40 percent.

Climate. Average annual precipitation in this area is 30-40 inches with 50-70 percent occurring in the form of snow, which often remains as a deep, persistent late-melting snowpack. Wind direction is predominately southwest. Temperatures range from a January low average of 13°F. to a July high average of 53°F. (extrapolated from Sula records by applying a lapse rate of 3°F./1,000 Ft.). Precipitation occurs primarily during spring and fall with deficiencies most likely to occur in July and August.

Geology and Soil. The stand area is underlain by granitic rock with exposures occurring as decomposed granite or isolated outcrops of hard granite. These outcrops have rounded surfaces and widely spaced jointing. Granite weathers easily, becomes soft and breaks down into a micaceous silty clay. It often weathers differentially so that within an exposure one may find hard rock in close association with decomposed rock. Because of the above characteristics, the granite is unsuitable for aggregate, is slightly acidic and easily eroded (2).

Six soil pits were dug throughout the stand. The forest soil specialist made soil profile descriptions and sent soil samples to a lab for chemical analysis. In general, he described the site as having well-drained sandy soils underlain at moderate depths with highly weathered granite rock (gruss) and overlain with a 6-10 inch surface layer of windblown loess. The upper few inches of soil have a moderate capacity to hold nutrients [Cation Exchange Capacity (C.E.C.) 20+], while the lower soil depths have a very low nutrient holding capacity (C.E.C. 7-). Moisture holding capacity is generally low because of the sandy soil texture, while root penetration is good. Soil data for this stand is included in the Appendix.

There are a few outcrops of granite boulders along the ridge lines, but generally rocks or rock fragments are not a problem, either on the surface or throughout the soil profile. Included are some spots of shallow soils over weathered granitic rock. The soils in the drier portions of the stand fit most closely within the Blackleed Soil Series.

By using the land capability rating system in current use on the Bitterroot National Forest, soil productivity is Low-Moderate.<sup>2/</sup> Erosion hazard, primarily because of the sandy texture and erosive loess layer rates High. Trafficability, an expression of the ability of roads to withstand use, is rated as Moderate. Mass soil movement potential is Low.

---

<sup>2/</sup>To use the land capability rating system, the rater selects an established number most closely related to an actual ground situation; for example a 40-60% slope may be a "5", a granite soil a "10", etc. These numbers are then totaled for a final rating described as either low, moderate, or high. See Appendix item 10.

Hydrology. The stand area, though containing no live water, surrounds a boggy basin from which flows an intermittent trickle of live water which constitutes a first-order stream. Because of the high elevation and persistent snowpack, snow melt occurs as a well-regulated late flow presenting no problems with respect to water quality and peak flows. Overland flow rarely occurs because of the coarse soil textures (38). At present, there are no established watershed production goals that will constrain silvicultural prescription. A hydrograph is included in the Appendix.

Summary of Physical Implications to Management.

The combination of cool temperatures, short growing seasons, and only fair soil implies that these factors will constrain site productivity for timber growth. High erosion hazards imply that special precautions against soil disturbance should be applied on any slope over 20 percent. Concentration of nutritive values in the thin wind-deposited layer of loess soil material further implies that displacement of this layer should be avoided in order to prevent depletion of soil productivity.

Trafficability problems can be expected during spring and fall rainy seasons with dust problems possible on heavily-used roads during dry weather. Mass soil movements should only occur rarely, but if encountered, should only be small and localized. The well drained character of the soil will permit development of windfirmness in tree cover, however, the topographic location of the stand suggests that windthrow will still present a risk to exposed trees.

## Chapter III

### ECOLOGICAL ELEMENTS

Ecoclass Identification. For broad land-use planning purposes, the R-1 Ecoclass System would place this stand in the "Coniferous" Formation, the "Subalpine Fir" Association, and Subseries Groups 4 (Cool and Moderately Dry) and 6 (Cool and Moist). These groups are identified by predictions of vegetative composition and productivity, and a prediction of constraining influences. This system is useful in defining limits and priorities of management and is refined further into habitat types which are discussed below (23).

Habitat Types. Daubenmire and Pfister have identified certain grass, forb, and shrub plants that are indicative of vegetative climax and to some extent, site productivity. Their resulting "habitat types" are used widely in R-1 (17).

A field reconnaissance by B. J. Losensky, Forest Ecologist, revealed that the cooler, drier ridgetop sites supported the AF/Xete (alpine fir/beargrass) habitat type, while more moist areas supported primarily the AF/Mefe (alpine fir/menziesia) habitat types. The AF/Xete habitat type supports a nearly pure stand of lodgepole pine, while the AF/Mefe habitat type supports a lodgepole pine stand with a greater representation of alpine fir, Douglas-fir and Engelmann Spruce in an understory position. In the above habitat types, lodgepole pine is a dominant seral species that is replaced by the alpine fir climax dominant in 100-200 years (17).

Wildlife. Prior to the burn, elk reportedly used the dense timber for escape cover during hunting season and during the hot summers retreated to the cool north slopes and wet areas to avoid heat and insects. Use by big-game after the burn was nearly eliminated because cover was practically gone over a large area. Today, big-game use in the burn is slowly increasing as tree crowns once again begin to provide cover. An occasional elk track or pellet group was the only evidence of big-game use found in three trips through the area last summer. No evidence of deer use was found.

Mountain bluebirds are abundant and apparently dependent on the open terrain with sufficient large trees such as dead snags to provide nesting sites (6). Ground squirrels were evident for a few weeks in early summer.

Although nearly all forms of wildlife common to the district have been sighted in the burn, no evidence other than that cited above was noted of any significant animal populations. Undoubtedly, a variety of game and nongame animals use and inhabit the area (14). All of these play roles in the ecosystem, but little is known concerning food and cover requirements, importance of interrelationships, or the animals ability to adapt. Because of the regional history of glaciation and recurrent fires, animals have preadapted themselves to changes in plant communities. No threatened or endangered species are known to be present or dependent on the area (24).



Domestic Animals. The stand area is part of the Sleeping Child Range Allotment which was established in 1964 to utilize transitory forage following the 1961 fire. The allotment objectives are to encourage the regeneration of trees wherever trees previously grew, and to utilize the transitory forage without constraining the water and timber resources. There are no range improvement structures in or around the stand. Current cattle use on the stand area is light, with most use confined to ridgetops or old spur roads. Carrying capacity has declined because of encroaching tree growth and cattle numbers have fallen off nearly 60 percent since 1970, the year of peak use. Except for an occasional tree along the ridgetop damaged by rubbing or trampling, cattle use poses no constraint to timber management. Grazing use might be extended for several years if stand improvement techniques are practiced.

Insects and Diseases. The young stand is presently unaffected by insect or disease problems. Problems that exist were eliminated or greatly reduced by the fire and by subsequent efforts to cut down or poison remaining infection sources. Several serious insect or disease problems were common in the previous stand and could pose future management problems:

Mountain pine beetle is a bark beetle that attacks lodge-pole pine in midsummer and chews into the phloem region of the tree. Associated with the beetle are two consistently present blue stain fungi. Spores of these microorganisms are inoculated into the trees by beetle activity. The trees respond with a flow of resin from severed resin ducts. If the flow is sufficient, beetles may be repelled and the fungi spores isolated. If the attack is too great and the resin

response insufficient, the tree is quickly girdled and killed by the fast-spreading fungi and the insect galleries. Mountain pine beetle is usually endemic in lodgepole pine stands and becomes cyclicly epidemic when stand age, tree diameters and climatic conditions permit. Beetle attacks serve the primary ecological function of preparing the stand for successional change. The level of stand resistance is highest up to about 60 years and then declines until resistance to attack is low at 80 years (+). During this age period if the majority of trees in the stand are over 10-12 inches dbh, an epidemic is possible (7). Mortality from mountain pine beetle will be a major natural cause of fuel buildup in this stand (14).

Dwarf Mistletoe, Arceuthobium americanum, is a parasite on lodgepole pine that adversely effects height and diameter growth, potential yield and fiber quality by blocking the downward movement of photosynthate to the roots (9, 10). It increases host susceptibility to other damage, particularly insects, and it attacks trees of all ages. No chemical or fungal controls are known, although fire and silvicultural controls are effective. The parasite is an insect-pollinated plant that shoots out a sticky seed that will germinate in the thin bark of a host tree. The disease usually spreads from tree to tree and in young stands may infect up to 35 percent of a stand within 30 years. Natural barriers such as ridges, roads, streams, or non-forested areas can effectively prevent infection of clean stands (11).

Western gall rust, Endocronartium harknessii, has been observed in the burn, but not in this stand. Round galls are formed on limbs and boles and have the effect of reducing tree growth, ruining its form, and sometimes actually killing the tree. Since there is no alternate host, removal of infected trees or limbs is an effective control measure (12, 13).

Fire. This stand has a recent and still vivid fire history. We know that preburn fuel loads were high because of suppression and insect created mortality. We also know that natural fire reduced those heavy fuels and was largely responsible for a stand composition heavy to lodgepole pine. Fire occurs periodically in the lodgepole pine forest of this region and is expected to recur under natural conditions (14).

Fire has definite relationships in seedling establishment, stand development, insect and disease control, and understory vegetation. In this stand, the fire was sufficiently intense to open serotinous cones, but yet cool enough to protect seed viability and insure dense reproduction. The fire apparently killed or knocked insect and disease pests back to endemic levels. In the preburn subalpine fir climax stand, fuel loading of live and dead material could have approached 60-80 tons per acre. A nearly pure lodgepole pine subclimax stand would have had 30-50 tons per acre (15). Similar volumes will have to be dealt with throughout the rotation of the present stand.

The present stand has an estimated dead-fuel loading of 10-15 tons per acre. An additional volume of around 5 tons per acre can be expected from smaller diameter slash resulting from release cutting (16). If ignited, this volume of fuel would threaten the entire

stand under favorable burning conditions. Presently, the stand is young and healthy. Duff depth is thin and most fire-killed woody residual is standing and over 3 inches in diameter. Based on the above, I estimate the current ignition potential and rate of spread to be low (14).

#### Ecological Implications to Management.

Lodgepole pine is expected to remain as a dominant stand component for many years with subalpine fir eventually gaining a climax position (17).

Big-game use will continue to improve as tree height increases to provide shade and cover. The site will probably not develop as key big-game summer range because of the close proximity of roads and the lack of live water. No winter range values exist. This implies that big-game values need not be featured and the wildlife considerations need not constrain other management opportunities. The same implications apply to domestic livestock use.

Stand health is currently not threatened by insect or disease enemies. This implies that biological potentials may be reached if managers are diligent in preventing outbreaks that create growth, quality and mortality loss. Early timber management efforts should seek to select against infected individuals or groups.

Mountain pine beetle infestation can be expected. If timber loss is to be minimized then maximum vigor and health will have to be maintained by controlling density and condition. Because mountain pine beetle is attracted to large mature trees, rotations for lodgepole pine should be limited to the age when maximum level of resistance or maximum current annual increment is reached (7).

The threat of recurring fire can be minimized by harvesting wood fiber volume that normally would accumulate from suppression and insect and disease mortality. This implies the need to prescribe stand treatments that will maximize useable wood fiber production. Even then, certain risks and special efforts will be required to prevent fire damage. If natural regeneration of lodgepole pine is desired, the controlled use of fire will be necessary to help insure success.

The AF/Xete habitat type can be classed in the low-medium productivity range with an estimated site index of 50 and a productivity class of III. The AF/Mefe habitat type is in the medium-high productivity range with an estimated site index of 60-70 and a productivity class of II (39). This implies, according to Wikstrom's and Wellner's lodgepole pine research, that proper management can increase harvest values in this stand by three to four times the expectations from unmanaged stands (37).

## Chapter IV

### BIOLOGICAL ELEMENTS

The following information is based on analysis of field data from twelve 1/300-acre sample plots taken in 1975, (see statistics in Appendix).

Stand Composition. The stand is composed of 75 percent lodgepole pine, 16 percent subalpine fir, 5 percent Douglas-fir and 4 percent Engelmann spruce. This composition constitutes 2,100 stems per acre. Although grass and forbs exist in the understory, they are not considered as competing vegetation.

Lodgepole pine, the more shade intolerant species, is developing a dominant overstory position in the emerging canopy, while the three more tolerant species are being submerged into understory positions.

Stand Condition. Stand condition is good. Although various diseases such as dwarf mistletoe and western gall rust existed in the previous overmature stand, the fire in 1961 apparently eliminated these conditions. The present stand is a young, healthy stand with no evidence of insect or disease problems. Occasional evidence of girdling by rodents was observed, but is not a problem.

Nearly all trees appear to have crown ratios <sup>3/</sup> of 85 percent or more, an indication that sunlight has not yet become limiting and that stagnation of height and diameter growth has not occurred. This is confirmed by calculating an average per acre Crown Competition Factor <sup>4/</sup> (CCF) of 84 based on the trees sampled. Alexander found that a CCF of less than 125 indicated that height growth was currently unaffected by density (5).

My CCF calculations are as follows:

---

3/The ratio of live crown length to tree height.

4/A measure of actual growing space per tree with 100 being an expression of full occupancy of available growing space.

CCF COMPUTATION

- Step 1 List sample trees by number of trees in each diameter class
- Step 2 Multiply the total number of trees in each diameter class by the MCA \*/ (Maximum Crown Area)
- Step 3 CCF = Sum of MCA values x conversion to acre basis

<u>Plot</u>	<u>Diameter</u>	<u>No. Trees</u>	<u>MCA</u>	
1	2"	1	.067	
	1	7	.040	Plot Size 1/300 Acre
2	1	9	.040	
3	2	2	.067	78 trees x .040 = 3.120
	1	9	.040	4 trees x .067 = .268
4	1	8	.040	<u>3.388</u>
5	1	5	.040	3.388 = CCF on 12/300th Acre
6	1	3	.040	
7	1	6	.040	∴ Ave. CCF/Acre = 84
8	1	5	.040	
9	2	1	.067	
	1	5	.040	
10	1	7	.040	
11	2	1	.067	
	1	7	.040	
12	1	7	.040	

\*/ MCA computed from equation  

$$MCA = 0.00365D^2 + 0.01676D + 0.01925$$



Stand Structure. The stand is developing from natural regeneration following the 1961 fire and is now 15 years old. A stand profile reveals an obvious height variation, due primarily to the emerging dominance of the intolerant lodgepole pine, plus microclimatic influences, rather than distinct age differences. Regeneration occurred over a period of several years and produced a stand with a single age class rather than a stand with trees all the same age. Because the range of ages is less than 20 percent of the length of rotation (120 years), the stand is still classed as even-aged (4). Current total heights range from a maximum of 12 feet, with lodgepole dominants averaging  $6\frac{1}{2}$  feet, down to seedlings less than a foot tall. Maximum total height of other species sampled was 5 feet, most occurring in the 1-2 foot height class. Diameters range up to 2 inches dbh, the average dominant tree being 1.3 inch dbh. Growth rates, taken at stump height because of small breast height diameters, indicate that site trees have grown between 7 and 35/20ths during the past 10 years with an average 10 year radial growth of 17/20ths or 1.7 inch of diameter growth.

Stand Genetic Assessment. Lodgepole pine is a prolific seed producer with seeds that remain viable for many decades (3). The previous stand contained lodgepole pine with serotinous cones occurring on both living and dead trees. Genetic selection, induced by fire, is likely responsible for this characteristic of serotiny common in lodgepole pine stands where fire has been recurrent and intense (14).

Though lodgepole pine seed is seldom dispersed more than 200 feet from the parent tree, it is a prolific pollinator with pollen grains capable of being windborne for many miles. From these characteristics, one can conclude that lodgepole pine in the present stand has good genetic variability from a large gene pool. Phenotypic variability is certainly evident.

Subalpine fir is comparatively less prolific and has poorer seed viability and germination success (3). Its seedlings probably contain somewhat less genetic variability. Engelmann spruce and Douglas-fir, because of both soil characteristics and high elevation, occur somewhat off-site in this stand. The genetic variability for these two species is expected to be quite low.

Certain trees of all species exhibit genetic resistance to insect and disease enemies and it is probable that this stand also contains individuals with these abilities.

#### Biological Implications to Management.

Lodgepole pine is the largest, most vigorous and dominant component of the stand. It is also healthy and well adapted to the site. Stocking is heavy, but not heavy enough to retard the expression of dominance and cause stand stagnation of height growth. Genetic variability for lodgepole is broad and phenotypic variance is apparent. Other species components are being overtopped and without release will remain suppressed and play a lesser role in early stand development.

From the standpoint of future management, biological conditions imply that this stand can be managed to produce useable volumes of lodgepole pine. Future stand treatments should favor trees that exhibit genetic resistance to insect and disease enemies. Trees with serotinous cones should also be favored in order to retain this unique and desirable characteristic of lodgepole pine.

Although high crown ratios are an indication of stand vigor, it is also an indication that early stocking reduction efforts may encounter lower live limbs on juvenile lodgepole pine. Personal experience with this problem has shown that lower live limbs left on the stump after release usually continue to grow, often with surprising vigor but poor form. It is important to stress removal of all live limbs on cut trees in order to assure release success.

## Chapter V

### SOCIO-POLITICAL AND ECONOMIC CONSIDERATIONS

Socio-Political. Assumptions made in the Resource Planning Act (RPA) Assessment indicate a growing national population and a continuing expectation that Americans will seek improvement in current living standards (21). Ravalli County population is growing faster than the national average and local incomes are lower than state and national averages (18). It is therefore likely that the political climate will favor increased expenditures to provide jobs and increase wood fiber production. A life style study made in the Sula area by a University of Montana anthropologist in 1975, predicted a continuing local dependence on timber products with increasing influxes of recreation landowners. Two major sawmills, six log home operations, and several post and pole plants currently operate in the Bitterroot Valley. Numerous independent loggers, many of whom are second generation Bitterrooters, depend on National Forest wood products or stand improvement contracts for their livelihood and are expected to continue to subsist in this manner as long as these markets and opportunities exist (19).

Clearcutting as a silvicultural method was widely criticized in the 60's and 70's, but as new plantations grow and more intermediate silvicultural methods become common, this criticism is expected to diminish. The stand is not visible from any major travel route or habitation except as an extreme background view 10-15 miles distant. It is in the immediate foreground from Road #717, but this road is only lightly used by the public and the natural focal points from it are west towards the high peaks of the Bitterroot Range.

Economics. The RPA draft assessment for timber predicts a national demand for softwood products to exceed supply by 6.8 billion cubic feet in 2020. To help meet this demand the assumptions are that major investments in growth and yield improvement, stand protection, and reforestation will be required. Three of the four alternative timber goals in the RPA call for investments in sites capable of producing more than 50 cubic feet of wood per acre per year. Stand 301.2-03 has this capability. The fourth alternative, Goal D, would invest in stands that produce only 20 cu. ft./acre/year (21).

Bennett, in his 1973 study on the Bitterroot National Forest (20), shows that yields on AF/Xete habitats can be substantially raised and suggests that there may be some economic and social merit in doing so in order to maintain stable employment. He questions that the cost is worth the investment.

Porterfield and Schweitzer, in a 1974 study of precommercial thinning of lodgepole pine near Ronan, Montana (22), also concluded that in a strict economic sense the return from additional timber produced was quite low. They calculated that lodgepole pine on site class III would have a 3.1 percent rate of return with an additional yield of 52 cu. ft./acre/year, and suggested that a break-even approach be used to assess precommercial thinning opportunities.

An Invest III Analysis for this stand supported the above conclusions when it indicated that any management combination that included precommercial thinning produced the lowest benefit-cost

ratios and the lowest internal rates of return.<sup>5/</sup> Productivity class tables for R-1, however, imply that precommercial thinning of class III sites is justified.

Socio-Political and Economic Implications to Management.

Socio-Political. Amenity value considerations are not expected to constrain silvicultural practices on this site. Visual sensitivity is low.

Local communities and life styles will continue to rely on future production of wood products from lands allocated to growing timber. The social and political need for jobs and raw materials will increasingly justify investment in timber stands that today remain at custodial levels of management.

Economics. A strict application of dollar and cent economics leads one to conclude that investment in this stand beyond the custodial level would be bad business. In other words, investments in any non-income producing stand improvement appear on the surface to be economically unjustified.

Based, however, on predicted product demands and nationally established levels of management; and based on the fact that the stand is already roaded and the land allocated to timber production; these other considerations outweigh strict economic conclusions and justify managing this stand to achieve its biological potential for useable wood fiber.

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<sup>5/</sup>See Appendix, item 4.

Strict economic considerations should be used to establish investment priorities. In this stand, that priority should rank the AF/Mefe habitat type over the AF/Xete with both having lower investment priorities than the warmer moister habitat types.

## Chapter VI

### SILVICULTURAL REQUIREMENTS OF KEY SPECIES

#### Lodgepole Pine.

Regeneration. Basic requirements are for bare mineral soil seedbeds, full sunlight, and annual precipitation of 21 inches or more.

Lodgepole tolerates short growing seasons and high temperature extremes. It does best when average July temperatures are between 55° and 63°F. (3). Artificial regeneration is usually not necessary in lodgepole pine, but is being practiced with good results. Planting of bare root stock, containerized seedlings and direct seeding has been successful. Natural regeneration is usually a reliable method of regeneration. Method and timing of slash disposal are often the most critical considerations (27). Because lodgepole often seeds in on disturbed areas with excessive stocking, Alexander suggests that burned seedbeds permit more uniform seedling distribution and therefore better stocking (28).

Juvenile Stands. A characteristic of many natural young lodgepole stands is dense overstocking. If stocking exceeds 2,000 stems per acre, a stand may never reach minimum sawtimber standards (22). If it exceeds 4,000 stems per acre, irretrievable growth loss due to stagnation may occur (29). Cole's studies indicate thinning at age 20 to a 10-foot average spacing will produce an optimum density for maximizing cubic volume growth over a rotation. Spacing decisions should include considerations of stand age, stand size, access, economics, product goals, ingrowth, and mortality factors.

Release cuttings are often important in dense stands to prevent growth loss. It should also be noted that juvenile trees are capable of producing viable seeds as early as age five. Early release will often stimulate cone production and result in unwanted interseeding.



Immature Stands. Lodgepole pine is characteristically a small diameter, thin barked, small limbed tree, usually exhibiting straight boles, good form-class and uniform size, and valued for posts, poles and pulpwood, grape stakes, house logs, and studs. Recent mill improvements permit utilization of small diameter material down to a 2½ inch top diameter.

Where stagnation is occurring, intermediate cutting can increase total production far above the untreated stand. In managed stands, thinnings will usually not increase growth, although growth can be redistributed to larger stems, mortality can be reduced, overall form and condition can be improved, vigor can be maintained, and often windfirmness can be improved (29).

Mature Stands. Clearcutting has developed as the most common regeneration method for overmature lodgepole pine because of poor stand condition and silvical requirements for regeneration.

For stands that have been under management and where condition and vigor class is still high, a shelterwood system is satisfactory. This system permits control of reproduction density, maintains amenity values, and offers an option to clearcutting. The group selection method can also be applied if one wants to develop an unevenaged plan of management (32).

Caution should be used in applying either of the latter two methods, since risk of windthrow and mortality from dwarf mistletoe or mountain pine beetle can be increased by partial cutting. Usually the shelterwood system is applied in three or four cuts depending on risk of windthrow. Stands with high windthrow risk or heavy mistletoe infection (70%+) should be clearcut. Stands infested with mountain pine beetle

should have infested and susceptible trees removed during the first cut. If insect populations are building, clearcutting may avoid the risk of an outbreak that could kill most of the merchantable stand (32).

#### Other Species.

Alpine fir, Engelmann spruce and Douglas-fir constitute a lesser fraction of the stand composition, with alpine fir most heavily represented. Because lodgepole pine is intolerant and achieves early dominance these species usually remain in an overtopped position where full development is suppressed for much of the rotation. The "other species" component is not expected to have an important role in stand management, however, superior trees of each species should be encouraged since they will help maintain diversity and can help provide even stocking of the stand area.

Subalpine Fir. This is a shade tolerant climax species characterized by slow growth and high susceptibility to fire, insects and disease. As a seedling, it cannot compete successfully with Engelmann spruce if light intensity exceeds 50 percent of full sunlight. Once established, it can respond with good diameter growth if released, even after long periods of suppression (3).

In a managed stand where rapid growth is important, the faster growing, more shade intolerant species such as lodgepole pine should be favored.

Engelmann Spruce. This species is less shade tolerant than subalpine fir, but more shade tolerant than lodgepole pine or Douglas-fir. Early growth is usually slow with poor expectations for improvement on

coarse textured soils developed from granite. It does well on moist, well-drained silt and clay loam soils with an accessible water table (3).

In the habitat and soil types encountered on this site, lodgepole pine should be favored over Engelmann spruce.

Douglas-fir. This species is slightly more tolerant of shade than is lodgepole pine. It grows well on the moister habitat types encountered in this stand and has an ability to maintain good height growth over a long period of years. It is considered along with lodgepole pine to be a subclimax species in this stand. Once established in light shade, it grows best in full sunlight (3). Dominant trees of this species should be favored over subalpine fir and Engelmann spruce, although as a stand component, lodgepole pine will remain as the most silviculturally significant species.

## Chapter VII

### MANAGEMENT ALTERNATIVES

#### Low Level Productivity - Protection Only - No Treatment.

In this alternative there would be no intermediate treatments; i.e., no release cuttings, no intermediate cuttings; only a regeneration cut at rotation age.

#### Advantages.

The advantages of this treatment are that no direct costs other than normal protection would be incurred unless catastrophic threats of insects, disease, or fire develop. Currently, good stand health and the high probability of harvest as soon as a merchantable size is reached make this seem a reasonable risk.

A probable final yield from this alternative would be about 2,900 cu. ft. in 120 years. This prediction is based on normal basal area limits for the above habitat types, diameter relationships developed from Myer's simulation model and actual growth plot data. See Table 4 in Appendix.

Soil disturbances would be delayed and erosion hazards would remain minimal. Big-game would enjoy heavy escape cover and other wildlife would be able to function with little interference by man. A regeneration cut at rotation age could employ the clearcut method which would be well suited to the biotic characteristics of this stand.

#### Disadvantages.

It will take longer to attain a yield of useable wood fiber. Porterfield and Schweitzer's study suggested that stands with over 2,000 stems per acre might not reach minimum sawtimber size even after

140 years (22). If this is true, the potential for losses by tree suppression, mountain pine beetle, fire, and disease over this extended period would be greater and could further reduce potential useable yield. Opportunities to identify and favor genetically superior trees would be lost. Cost of release cutting, if management intensity should change in the next 10-15 years, would be higher due to increased size of material and resulting increase in fuel volumes.

#### Mid-Range Productivity - Extensive Timber Management.

"Extensive" is defined to mean the practice of forestry on the basis of low operating and investment costs per acre (25). This is an imprecise definition that allows some liberty of application.

Two alternatives are discussed below:

Prescribe no initial release cutting, but include one or more intermediate cuttings prior to a regeneration cut.

#### Advantages.

No early non-income producing investments will be required.

Mortality can be captured.

Superior trees can be favored and inferior trees utilized.

Useable yields can be increased.

Product values can be raised.

Stand health can be improved.

Stand composition can be controlled.

A probable total yield from this alternative would be about 4,200 cu. ft. in 120 years. This estimate is based on the same relationships used in Alternative A, except intermediate cuttings were scheduled to maintain basal areas to optimum stand densities approximately 60 percent of normal. See Table 5 in Appendix.

Disadvantages.

Potential useable yield is reduced due to overcrowding of the stand prior to commercial entry.

Risks of soil and water degradation due to disturbance will be greater, as will risks of windthrow and other mortality.

Big-game escape cover will be reduced.

Slash disposal costs will increase with multiple entries.

Prescribe a release cutting followed by one or more intermediate cuttings prior to a regeneration cut.

Advantages.

Juvenile vigor can be maintained without treatment of growth reduction due to overcrowding.

Later slash costs may be reduced by early elimination of excess stocking.

Mortality can be captured.

Stand composition can be controlled.

Probable yield potential with this alternative will approximate 6,800 cu. ft. This estimate is based on growth sample tree data from Stage I sample plots on this district and in these habitat types. Removals are scheduled so as to maintain optimum stand basal area at about 60 percent of normal. See Table 6 in Appendix.

Disadvantages.

Higher investment costs are incurred.

Early release residues will increase wildfire risk for 5-10 years until naturally abated.

Risks of soil and water degradation due to disturbance will be greater, as will risks of windthrow and other mortality.

Slash disposal costs will increase with multiple entries.

Prescribe an early release treatment with no further treatment until harvest.

#### Advantages.

Juvenile vigor can be maintained as overcrowding will be prevented.

Ground disturbance will be minimized as will future slash costs.

Probable yield would be around 6,000 cu. ft., a two fold increase over Alternative A. This prediction is based on growth sample tree data from Stage I plots, as in prescribing a release cutting followed by one or more intermediate cuttings prior to a regeneration cut. Basal area was maintained at normal levels for these habitat types. See Table 7 in Appendix.

Game cover would be maintained at levels above the two alternatives and high range productivity - intensive timber management.

#### Disadvantages.

There would be no opportunity to capture mortality or control insect and disease outbreaks.

Investment would be higher than in the alternative of low level productivity - protection only - no treatment.

Early fire risk would be high.

High-Range Productivity - Intensive Timber Management.

"Intensive" means to practice forestry so as to obtain a high level of volume and quality per acre by applying the best techniques of silviculture and management (25).

In this case the following alternative is offered:

Prescribe an early release cutting followed by fertilizer application, several intermediate cuts - also with fertilizer applications, and a harvest cut designed to use artificial regeneration using genetically superior seedlings.

Advantages.

Maximum potential yields could be produced (33).

Inferior genotypes could be replaced.

Juvenile vigor can be maintained without treatment of growth reduction due to overcrowding.

Probable yield potential with this alternative will approximate 6,800 cu. ft. This estimate is based on growth sample tree data from Stage I sample plots on this district and in these habitat types. Removals are scheduled so as to maintain optimum stand basal area at about 60 percent of normal.

Disadvantages.

Benefit/cost ratio would be very low due to high investments.

Early release residues will increase wildfire risk for 5-10 years until naturally abated.

No potential volume is predicted for this alternative because available data is insufficient. Indications in Cochran's study, however, suggest that volume increases of 60 percent may be possible with fertilization. Tree improvement studies in lodgepole pine are just



getting started and are expected to produce seed from seed orchards by the late 1980's. Wikstrom and Wellner also suggested that pruning at age 30-50 years could increase the value of a thinned medium site lodgepole pine stand by a factor of three by improving the quality of the final product (37).

## Chapter VIII

### MANAGEMENT EMPHASIS

This stand should be managed under the second alternative in Chapter VII, to produce useable cubic foot volumes at a mid-range of stand productivity potential. Guidelines consistent with multiple use management direction for this area should apply.

This stand is fully stocked, young, thrifty, healthy, and already accessible by road. The second alternative secures these advantages by capturing and maintaining early growth potential. Alternatives that do not include stocking control and maintenance of optimum stand density risk forfeiture of these values. Recognized are physical limitations of climate and soil; ecological risks of insects, disease and fire, and low expectations for high dollar return on investments.

The indicated potential productivity of the stand, a modest 57 cu. ft./year ( $6,800 \div 120$ ) places it within the nationally accepted range for investments in timber stand improvement (21). This estimate is felt to be safe but conservative in view of Wikstrom and Wellner's findings that indicate much higher productivity results following release cuts.

Maximum levels of productivity, in lodgepole pine, have yet to be attained in field trials and would likely be tested and applied first on sites with fewer physical limitations. Intensive management using fertilizer applications and genetic stock is therefore not justified at this time (33), however, the option of managing this stand intensively is retained by the alternative selected.

Short Run (Next 10 Years)

Reduce stocking levels to maintain or improve tree vigor and prevent eventual loss of growth potential due to overstocking.

Favor lodgepole pine as the key species to manage.

Favor those trees exhibiting superior growth, form and disease resistance.

Design natural fuelbreaks to break continuity of eary fuel accumulations.

Design first entry to minimize ingrowth and regrowth from seedlings and stumps.

Long Run (Beyond Next 10 Years)

Maintain height and diameter growth without stand density restrictions throughout the rotation.

Utilize intermediate cuts to remove those trees attacked or susceptible to attack by insects or disease and those trees damaged by other forces of nature.

Schedule final harvest cuts to avoid premature loss by epidemic mountain pine beetle attacks or windthrow.

Design regeneration cuts and site prep activities to assure natural regeneration of lodgepole pine.

Minimize risk of fire mortality by maintaing safe levels of fuel accumulation.

Several growth projection models were used, but none provided data that compared favorably with actual Stage I plot data available on this forest and district. Each is discussed on the following page.

Stage's growth projection model did not correct for stand density and produced unreliable diameter and volume conclusions. This model was used to compare stand structure. Printouts are included in the Appendix in Table 8.

Myer's growth simulation model produced diameter predictions significantly below known diameter potential on these sites. His model was used only to evaluate diameter relationships between managed and unmanaged stand conditions. Printouts are included in Table 9.

A model available from Champion International was employed based on soil series, average diameter breast high (dbh) of site trees and stems per acre. This model seemed to fall short of actual growth plot potential, probably because soil series identification was sketchy. This model was used to compare growth response based on selected treatments, but it was not used for yield predictions.

Because this stand is still so young and small, I did not feel comfortable with the above simulation models with equations designed for larger trees. Instead, I went to the Stage I survey records taken in 1972 for this forest's timber management plan. Isolating the data from stands on this district and in these habitat types, I tabulated all the age diameter and height information on each lodgepole pine growth sample tree encountered, which gave me data from over 80 sample trees in the dominant and codominant size class. These trees represented the best lodgepole growth that an unmanaged stand on this district could produce. I concluded that the average tree in a managed stand should be able to do at least as well as these dominant trees in an unmanaged stand. I then graphed these variable and ran regression analyses on them to establish growth curves of known reliability. My predictions of yield are based on these curves.

To compare alternatives, I prepared Tables 4-7, and predicted yields based on the above data and on normal basal area guides for these habitats as published in Pfister's work.

I feel the predicted yields are reasonable though conservative. I could not accurately predict growth response from the second and third entries, but lodgepole pine diameter growth is expected to respond to stocking control. R-1 tables available for western larch, a similarly intolerant species, indicate that stand densities of .6 produce diameter growth rates 20 percent higher than overstocked stands. I conclude, therefore, that management will produce yields equal to, and probably better than, those predicted.

Twelve Stage I, 1/300th acre sample plots were taken in 1975. This data provided the basis for my prescription. See Appendix for sampling statistics.

Stand 301.2-03 should be managed as a single even-aged stand on a 120-year rotation.

First Entry (1975-1980). All short run silvicultural objectives should be realized by this entry.

A release cutting that will reduce stocking to 436 stems per acre (10' x 10') should be scheduled prior to calendar year 1980. This schedule will help maintain current annual increment that normally tends to culminate in natural stands around age 20. Research by Cole suggests that this level of stocking will be optimum for this age class in order to maximize cubic volume growth (29)

Since lodgepole pine predominates, it will be managed as the key species. Crop trees, however, should be selected for their superior size, form and condition, rather than species.

The main ridge line should be left unthinned for a distance of two chains down from the top, and one chain wide unthinned strips should be left down each spur ridge to Road #717. An additional unthinned strip 10 feet wide should be left along the top of the cutbank above Road #717. These strips will serve as fuel breaks during the 5-10 year period when flashy thinning fuels will be most hazardous. No later attempt will be made to reenter the stand for release cuttings in these strips.

Crews or contractors should be instructed to sever excess trees at ground level to minimize lower live limb "turnups." They should also be accountable for removing all excess trees, including seedlings, over 3" in total height. Spacing requirements of 10' x 10' are intended to be average rather than mechanically uniform, with allowances made to favor the tree best suited to a particular micro-site.

Second and Third Entries. The objective of these entries at age 70 and 80 will be to utilize damaged, dead, or dying trees and maintain the stand at a stand density optimum for continued growth and vigor.

To achieve this objective, an initial intermediate cut at age 70 will be scheduled in 2031. At this time, average size class will be 7" dbh x 47 feet. Approximately 64 trees, or 364 cu. ft./acre, should be removed. In 2041, another intermediate cut should be scheduled and approximately 100 trees, or 780 cu. ft./acre averaging 8" dbh x 51 feet, will be removed.

In both entries, a combination selection-low thinning will be employed. Selection thinning will be employed to remove rough dominants from the overstory. These will be excessively limby, forked top, or damaged dominant trees that may be holding back adjacent codominant or

intermediate trees of better form. The low thinning will be applied to remove as many overtopped and intermediate trees as necessary to maintain the stand at optimum basal area. See Table 6 of Appendix.

Close utilization will be encouraged to reduce fuel loads. Slash should be handpiled only to the level needed to break fuel continuity and reduce fuel hazards to a medium level of no more than a ton per acre in material below 3' in diameter. Terrain and soil conditions suggest that this treatment should be conducted with small lightweight equipment on frozen or snowcovered ground. Trees with broken tops, open scars, mistletoe infection, chlorosis, or visible vigor loss should also be removed during these entries. Care should also be taken during these entries to be sure that enough trees bearing serotinous cones are left until final harvest. Final Entry. The objective of final entry will be to harvest all trees in the stand, including the fuel breaks, and regenerate the stand naturally to lodgepole pine.

This entry will be made in year 2081. Because of the higher elevation, stand vigor and smaller tree diameter, this stand can be held longer with less risk from mountain pine beetle mortality. Slash accumulations, depending on degree of utilization, will be either broadcast burned or jackpot burned to reduce fuels and to stimulate seed cast from serotinous cones. To protect soil values and prevent erosion, this entry should be conducted with lightweight skidding equipment, preferably on frozen or snow-covered soil. No additional spur roads or skid trails need be constructed.

Regeneration. Natural regeneration of lodgepole pine can reasonably be expected because of seed dispersal and viability characteristics discussed in Chapter VI. Alexander found that the most acceptable and uniform stocking occurred on burned seed beds and concluded that slash disposal by jackpot or broadcast burn methods would provide best stocking (28). Soil disturbance during site prep operations should be avoided. If genetically improved stock is available, at harvest time, then slash disposal methods designed to minimize natural regeneration may be employed.



## Chapter IX

### IMPACTS OF PRESCRIPTION

#### Physical.

There will be no adverse or beneficial physical impacts from the first entry. This was substantiated in a 1974 environmental analysis of proposed release cuttings in the burn, in which Bitterroot National Forest soil and water specialists were involved (16).

In the second, third, and final entries, skidding and slash disposal efforts could cause accelerated erosion and undesirable displacement of the fertile loess layer. To prevent this damage and to repair damage where it occurs, the following should be considered:

Skid only with small lightweight equipment such as horses, or crawlers and wheeled vehicles in the D-2 to D-4 size range.

Skid on frozen ground and snow base and avoid machine piling of slash to prevent disturbance to the loess soil layer.

Although the second and third entries will cause insignificant hydrologic impact, the final entry will have an effect as follows:

On-site water yields will increase about 25 percent due to reduced evapotranspiration, snow redistribution, reduced interception, and more efficient conversion of snow pack to streamflow (from hydrograph in Appendix item 2).

This will have a primary effect of extending the runoff period into July.

These impacts are considered negligible because this is a first order drainage where nearly all the water goes off as ground water. This impact will have to be assessed in relation to other activities in the drainage at that time.

Biotic.

First Entry. The first entry will alter stand composition so that lodgepole pine will constitute 95 percent of the residual. Douglas-fir and Engelmann spruce will each constitute 2 percent, with subalpine fir the remaining 1 percent. Grasses and forbs will be temporarily stimulated by increased availability of sunlight and moisture.

Stand structure will have a more even aged appearance with average heights and diameters more uniform at 1-2 inches dbh and 7-10 feet in height. Trees undesirable because of small size, poor form or infection will have been removed, and remaining trees will be phenotypically superior. High crown ratios and therefore optimum height and diameter growth will be maintained and perhaps improved. Root competition for moisture and nutrients will be reduced.

Second and Third Entries. Stand composition will remain essentially the same with the exception of an expected influx of climax species in the seedling/sapling size class. These trees will remain suppressed in the understory unless overstory mortality permits their release.

Stand structures will be improved with the removal of the smaller size classes. Average dbh and height will be increased and diameter growth rates will be stimulated by increased sunlight and moisture availability. Growth models of this stand indicate an expected growth response following these treatments of 10-20 percent. Undesirable trees will once again be removed, thereby improving stand condition.

Final Entry. This entry will remove approximately 5,600 cu. ft./acre in year 2081. The stand will be regenerated naturally following slash disposal. Since high summer temperatures may cause serotinous cones in slash near the ground to open and cast seed, disposal should be scheduled within one to two seasons to retain seed viability and assure regeneration success (23).

Ecological.

First Entry. This entry will retard improvement of big-game cover for 5-10 years, but will extend for the same period domestic forage values. Based on present low use, this impact will be small. If any diseased trees are found, they will be removed.

Fuel loads resulting from thinning slash will increase by 3 to 10 tons per acre. These fuels will be fine and flashy. Prescribed unthinned fuel breaks will tend to isolate these accumulations, but alert prevention and detection measures will be needed to avoid fire damage during dry periods. This increased fuel hazard can be expected to decline markedly within 5 to 10 years as slash deteriorates (16). Natural mortality is expected to be reduced because of reduced stocking and maintenance of tree vigor.

Second and Third Entries. These entries will open the stand and reduce security for big-game. This impact will be off-set by temporarily increased forage values. Insect and disease potential will be reduced by removing susceptible or infected trees. Slash accumulations will be slight if utilization methods continue to improve, but if slash does remain, handpiling will reduce the hazard.

Final Entry. This entry will end the rotation and is planned to preclude expected mortality from mountain pine beetle and fire that frequently occurs in stands of this size and age. Escape cover will be eliminated on all acreage being treated.

Socio-Political-Economic.First Entry.

Release cutting will have no adverse visual impacts. It will provide manual labor employment for approximately 60 mandays.

Economically, according to Invest III Analysis, the treatment ranks as a third choice compared to the alternative of no treatment, and the alternative of commercial thinning and harvest.

Based on a benefit-cost analysis and despite the low ranking, the selected alternative still has a favorable benefit-cost ratio even at a 6 percent interest rate. This low-ranking is due chiefly to the high carrying costs required of a precommercial thinning early in a rotation, it does not consider other benefits to man.

A positive but unquantified economic impact of this entry is the prevention of long-term ecological impacts that could become quite costly; i.e., insect and disease and fire. Another positive economic impact is the securing of growth potential.

Second and Third Entries.

There will be no adverse socio-political or economic impacts from intermediate cuts. Both entries will beneficially provide employment and raw material and minimize losses from natural mortality.

Final Entry.

The visual impact of clearcutting will be minimized to acceptable limits of modification by the long viewing distance and the natural terrain features of the unit. Economically, this entry will be income producing, however, since future stumpage prices can only be speculated, it will not be clear until that time whether or not the total treatment was worth the investment.

## Chapter X

### CONCLUSION

This prescription is consistent with current land management direction for the Bitterroot National Forest. It anticipates and helps establish management direction for the Bertie Lord - Meadow - Cameron Planning Unit on the Sula Ranger District. Impacts on all resources have been held to acceptable levels.

In prescribing treatment I have purposefully weighed the physical, biological, ecological, and socio-political potentials more heavily than the economic potentials. I feel the current methods of economic analysis are more valid for land allocation decisions than for project level decisions where commitments to development have already been made. At the project level, an economic analysis is most useful for selecting priorities of investment.

In order to secure the growth potential of this stand, the first entry investment is most critical. A delay beyond the time frame prescribed will begin to cause irrevocable reduction of growth potential--potential that 60 years from now, with a growing population and a shrinking land base, we will have a definite need for.

## APPENDIXES

### SOIL DATA - STAND 301.2-03

Mapping Unit I - This is a complex area of Andic Cryochrept, loamy over sandy mixed and Typic Cryochrepts, sandy mixed each of which occupies about half the area. The Andic Cryochrepts occupies the slight depressions and very gentle sloping areas while the Typic Cryochrepts are on steeper slopes and westerly exposures. Included are some spots of very shallow soils over weathered granitic rock and patches of rock outcrops. (See profile description of these soils)

Mapping Unit II - This unit occurs in depressional areas mostly at stream headlands and along drainages. The soils are mostly moderately well drained with seasonal subsurface moisture. Included are small areas of very wet boggy spots and areas that are well drained. (See soil description)

#### Notes

It is my assumption that the loess mantle at one time occurred throughout the area. Due to erosion processes, this mantle has been removed from much of the area, especially in areas least protected from erosive forces such as southerly aspects.

The very surface layer of these soils have somewhat higher pH than their subsoil. This is due to burning and accumulation of wood ash.

The CEC (cation exchange capacity) is the total of exchangeable cations (Ca, Mg, Na, K, H) that a soil can absorb. The cations of a soil solution are one source of nutrition for plant growth. The CEC is largely a function of clay and organic matter content. The CEC of the soil at pit no. 2 is representative of the granitic soils on the Bitterroot. Their capacity to hold nutrients is moderate in the upper few inches of the soil, (A and B horizons), however, is very low in the IIC horizons or those weathered from granitic rock.

These are moderately well drained (seasonal water table at depths from 15-24 inches) sandy soils that have a thick (6-10 inches) surface layer of wind-blown ash mantle (loess). They occupy gently sloping depressions and drainage areas.

Following is a typical profile description of this soil. It is pit no. 9, located in the NE $\frac{1}{4}$ , NE $\frac{1}{4}$ , Sec. 8, T2N, R18W.

Classification: Andic Aquic Cryochrept, loamy over sandy, mixed.

O 1-0" ashes and charred wood fragments

A 0-2" dark brown (10YR3/3) loam, weak fine granular structure, friable when moist, nonsticky and nonplastic, pH 7.0, abrupt smooth boundary.

B2 2-9" strong brown (7.5YR5/6) loam to silt loam weak fine granular structure, friable when moist, slightly sticky, nonplastic, pH 6.5, abrupt smooth boundary.



B3 9-13" dark brown (7.5YR4/4) sandy loam, weak fine granular structure, friable when moist, slightly sticky, nonplastic, pH 6.0, clear smooth boundary.

IIC 13-36" pale brown (10YR6/3) with common fine distinct brownish yellow (10YR6/6) mottles, gravelly loamy sand to gravelly sand, single grain, 25 to 30 percent by volume of granitic coarse fragments ( $\frac{1}{4}$ "-12" diameter), pH 6.5.

These are well drained, sandy soils that are underlain at moderate depths with highly weathered granitic rock (gruss). They occur on rolling mountainous lands at elevations from 5500 to 7200 feet.

Following is a typical profile description of this soil. It is pit no. 2 above Rd. No. 717, located in the NE $\frac{1}{4}$ , NE $\frac{1}{4}$ , Sec. 8, T2N, R18W.

Classification: Typic Cryochrept, sandy, mixed.

O 1-0" ashes and leaves and twigs. This layer is discontinuous.

A 0-3" dark brown (7.5YR3/2) sandy loam, weak fine granular structure, friable when moist, nonsticky, nonplastic, many fine roots, pH 7.0, cation exchange capacity\* 21.10, abrupt smooth boundary

B 3-8" dark brown (10YR4/3) loamy sand, single grain, nonsticky, nonplastic, many fine roots, pH 6.2, cation exchange capacity 13.54, clear smooth boundary.

C1 8-18" pale brown (10YR6/3) gravelly loamy sand, single grain, nonsticky, nonplastic, common fine roots, pH 6.2, cation exchange capacity 6.78, clear smooth boundary.

C2 18-24"+ light yellowish brown (10YR6/4) gravelly sand. This horizon is about 80 percent weathered parent rock which is coarse-grained quartz monzonite, few fine roots.

\* Milliequivalents/100 grams of soil.

These are well drained sandy soils that are underlain at moderate depths with highly weathered granitic rock (gruss). They have a thin (6-10 inches) surface layer of wind-blown ash mantle (loess).

Following is a typical profile description of this soil. It is pit no. 6 located on ridgetop in the NE $\frac{1}{4}$ , NE $\frac{1}{4}$ , Sec. 8, T2N, R8W.

Classification: Andic Cryochrepts, loamy over sandy, mixed.

O 1-0" ashes and charred wood twigs.

- A 0-2" dark brown (7.5YR3/2) loam, weak fine granular structure, friable when moist, slightly sticky and slightly plastic, many fine roots, pH 6.5, abrupt smooth boundary.
- B2 2-12" dark brown (7.5YR4/4) loam, weak fine granular structure, friable when moist, slightly sticky and slightly plastic, many fine roots, pH 6.0, clear wavey boundary.
- IIC1 12-15" brown (10YR5/4) loamy sand, single grain, nonsticky, nonplastic, common fine roots, pH 6.0, clear smooth boundary.
- IIC2 15-30" light brownish gray (10YR6/2) loamy sand and gravelly loamy sand, single grain, nonsticky, nonplastic, pH 6.0, few fine roots. This profile is about 60% highly weathered parent rock which is coarse-grained quartz monzonite.

The A and B horizons are developing in wind blown "loess" deposition.  
The IIC horizons are from weathered parent rock.

By Norm Davis  
BNF Soil Scientist  
1975

TO: Dave Filius, Ranger  
Sula Ranger District

12/75

FROM: Norm Davis

SUBJECT: Soil Series Study Plot

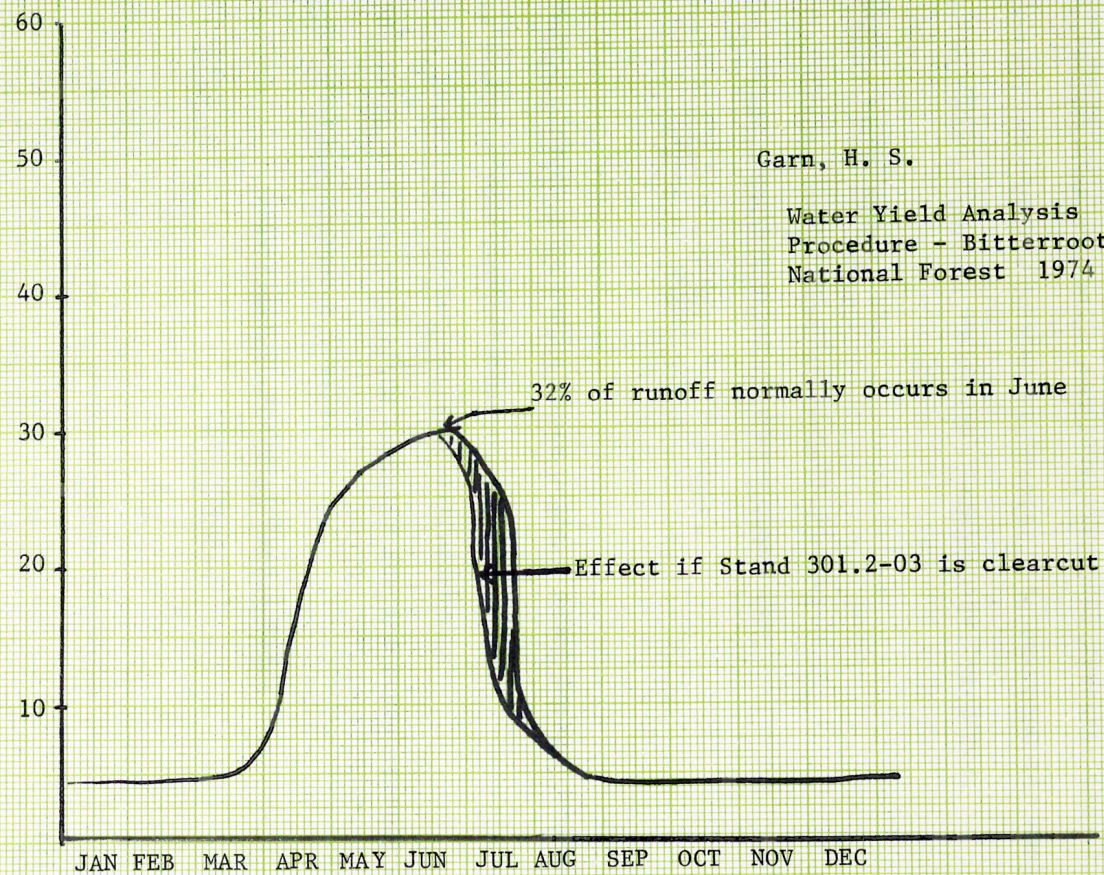
The soil on the dry portion of your study area fits the concept of the Blackleed Series. The soil was mapped and characterized in Mineral Co. St. Regis-Ninemile survey on Lolo N.F. The moderatley well drained analogue which occurs through the middle of the study area has not been characterized. Hope this will help some.



## HYDROGRAPH FOR STAND 301.2-03

% of annual runoff

Garn, H. S.

Water Yield Analysis  
Procedure - Bitterroot  
National Forest 1974



STATISTICS

R-1 guidelines suggest that a sampling error not greater than 15 percent be achieved for stands 20 acres or larger. If the computed sampling error exceeds 20 percent, additional samples are required.

NUMBER OF PLOTS NEEDED: (N)

1. Assume coefficient of variation of 45
2. Assume sampling error of 15 percent (E%)
3.  $N = \frac{CV^2}{(E\%)^2} = \frac{2025}{225} = 9 \text{ plots}$

Twelve 1/300th acre sample plots using a 40BAF Spiegall Relaskope were used for this prescription.

Plot locations were mechanically established.

Following are the statistics computed for the actual sample taken.

They are within acceptable limits:

Statistics of Actual Sample Plots

<u>Plot</u>	<u>No. Trees</u>	
	X	X <sup>2</sup>
1	8	64
2	9	81
3	11	121
4	8	64
5	5	25
6	3	9
7	6	36
8	5	25
9	6	36
10	7	49
11	8	64
12	7	49
	$SX = 83$	$SX^2 = 623$

S = Algebraic Sum

N = Number of Plots Taken

1. Computation of the mean ( $\bar{x}$ ):

$$\bar{x} = \frac{SX}{N} = \frac{83}{12} = 6.92 \text{ trees/plot}$$

2. Computation of standard deviation (D):

$$D = \frac{1}{N} \sqrt{N(SX^2) - (SX)^2}$$

$$D = .0833 \sqrt{12(623) - 83^2}$$

$$D = .0833 \sqrt{7476 - 6889}$$

$$D = .0833 \sqrt{587} = .0833 \times 24.23$$

$$D = \pm 2.02$$

3. Computation of standard error (E):

$$E = \frac{D}{\sqrt{N}} = \frac{2.02}{3.46} = \pm .58$$

4. Computation of percent of error (E%) or standard error of the mean:

$$E\% = \frac{E}{\bar{x}} (100) = \frac{.58}{6.92} =$$

$$E\% = 8.38\%$$

5. Computation of coefficient of variation (CV):

$$CV = \frac{D}{\bar{x}} = \frac{2.02}{6.92} = .29$$

$$CV = 29$$

## INVEST III ECONOMIC ANALYSIS

Projects Ranked by Their Net Present Worths at 0.0 Percent

<u>Problem Title</u>	<u>*Benefit/Cost Ratio</u>	<u>NPW At 0.0%</u>	<u>IRR</u>
Alternative No. B1	3.3	\$308,722.00	101.00
Alternative No. B3	2.5	17,493.57	9.14
Base Problem A	3.1	5,778.69	101.00
Alternative No. B2	1.6	5,078.85	7.08

\*At O.M.B. Rate of 5.12%

TABLE 4

PROJECTED YIELD TABLE - ALTERNATIVE A  
(No Release, No Intermediate Cuts, Harvest Only)

<u>AGE</u>	<u>NO. TREES</u>	<u>MORT</u>	<u>DBH</u>	<u>HT</u>	<u>FT<sup>3</sup></u>	<u>TOTAL FT<sup>2</sup> BA*</u>	<u>TOTAL FT<sup>3</sup></u>
20	2100	.005	2.3	14			
40	1890	.02	3.2				
60	1134	.03	4.6	40		.196 - 222	
70	793	.03	5.4	44	2.5	.267 - 212	
80	555	.03	6.2	48	3.5	.349 - 193	
90	388	.015	6.9	53	5.7	.442 - 172	
100	330	.015	7.7	57	9.4	.545 - 179	
110	280	.015	8.5	59	9.4	.660 - 185	
120	238	.015	9.2	63	12	.785 - 186	R 2856

\*Normal Basal Area for AF/Xete and AF/Mefe Average  $190 \pm 20 \text{ Ft}^2$  (39).



TABLE 5

PROJECTED YIELD TABLE - ALTERNATIVE B1  
(No Release, Two Intermediate Cuts, Final Harvest)

<u>AGE</u>	<u>NO. TREES</u>	<u>MORT</u>	<u>DBH</u>	<u>HT</u>	<u>FT<sup>3</sup></u>	<u>TOTAL FT<sup>2</sup> BA*</u>	<u>TOTAL FT<sup>3</sup></u>
20	2100	.005	2.3	14			
40	1890	.02	3.2				
60	1134	.03	4.6	40		.196 - 222	
70	793		5.4	44	2.5	.267 - 212	
	R493					R 132	R 1232
80	300	.001	6.2	48	3.5	.349 - 104	
90	297		6.9	53	5.7	.442 - 131	
	R 97					R 43	R 553
100	200	.001	7.7	57	9.4	.545 - 109	
110	198	.001	8.5	59	9.4	.660 - 130	
120	196		9.2	63	12	.785 - 154	R 2352
TOTAL FT <sup>3</sup> REMOVED (R) = 4137							

\*Normal Basal Area is  $190 \pm 20$  sq. ft. (39). Optimum Basal Area is 102-126 sq. ft. or 60% of Normal.

TABLE 6

PROJECTED YIELD TABLE - ALTERNATIVE B2  
(One Release, Two Intermediate Cuts, Final Harvest)

<u>AGE</u>	<u>T/A</u>	<u>MORT</u>	<u>DBH</u>	<u>HT</u>	<u>FT<sup>3</sup>/TREE</u>	<u>TOTAL FT<sup>2</sup> BA*</u>	<u>TOTAL FT<sup>3</sup></u>	<u>YEAR</u>
20	436	.001	2.3	14				1981
40	427	.001	3.9	29				2001
60	418	.001	5.9	42	2.8	.196- 82		2021
70	414		6.9	47	5.7	.267-111		2031
	R64					R 17	R 365	
80	350		7.9	51	7.8	.349-122		2041
	R100					R 35	R 780	
90	250	.001	8.9	55	12.0	.442-110		2051
100	248	.001	9.9	59	14.0	.545-123		2061
110	246	.001	10.9	62	17.0	.660-162		2071
120	243		11.8	66	23.0	.785-191	R5612	2081

TOTAL  
REMOVED (R) = 6757 FT<sup>3</sup>

\*Normal Basal Area is 190±20 sq. ft. (39). Optimum Basal Area is  
102-126 sq. ft. or 60% of Normal.

TABLE 7

PROJECTED YIELD TABLE - ALTERNATIVE B3  
(One Release, No Intermediate Cuts, Final Harvest)

<u>AGE</u>	<u>NO. TREES</u>	<u>MORT</u>	<u>DBH</u>	<u>HT</u>	<u>FT<sup>3</sup>/TREE</u>	<u>TOTAL FT<sup>2</sup> BA*</u>	<u>TOTAL FT<sup>3</sup></u>
20	436	.001	2.3	14			
40	427	.001	3.9	30			
60	418	.005	5.9	42	2.8	82	
70	397	.005	6.9	47	5.7	.267-106	
80	377	.005	7.9	51	7.8	.349-131	
90	358	.005	8.9	55	12.0	.442-158	
100	340	.01	9.9	59	14.0	.545-185	
110	306	.015	10.9	62	17.0	.660-202	
120	260		11.8	66	23.0	.785-204	R 5980
TOTAL REMOVAL (R) = 5980 FT <sup>3</sup>							

\*Normal Basal Area for This Habitat Mix is 190±20 sq. ft.

R-1 Volume Table #LP21

TABLE 8

STAGES GROWTH PROGNOSIS MODEL  
(Condensed from Printout)

<u>Year</u>	<u>Attribute</u>	Fraction of Stand					<u>Total</u>	<u>Species</u>
		.9	.7	.5	.3	.1		
		<u>(Lowest DBH in Stand Fraction)</u>						
1975	Stand - Trees			1.1			1468 No/A	75% LP1
	Volume			1.1			39 CuFt	
	Removal						1032 No/A	
	Volume			1.1			23 CuFt	62% LP1
	Residual			1.1			436 No/A	95% LP1
2021	Stand - Trees			8.3			275 No/A	
	Volume			11.1			2797 CuFt	96% LP1
	Removal						139 No/A	
	Volume			7.7			649 CuFt	94% LP1
	Residual			11.1			136 No/A	
2041	Stand - Trees			14.8			111 No/A	
	Volume			13.6			4733 CuFt	98% LP1
	Removal						109 No/A	
	Volume			18.6			4639 CuFt	98% LP1

TABLE 9

## MYERS MODEL

(Entire Stand Before and After Thinning)

Preliminary yields per acre of even-aged stands of lodgepole pine in Montana and Idaho.

SI (100) = 50      Elev. = 6900 Ft.

Proposed Thinnings: Start - 20 Years: Cycle - 10 Years:

---

<u>Stand Age (Years)</u>	<u>Trees No.</u>	<u>Ave. DBH In.</u>	<u>Ave. Height Ft.</u>	<u>Total Volume Cu. Ft.</u>
20	436	2.3	20	80
30	423	3.3	24	250
40	414	4.1	29	480
50	408	4.8	33	760
60	404	5.4	37	1080
70	401	5.9	41	1430
80	400	6.4	45	1840
90	399	6.8	48	2240
100	399	7.2	51	2690
110	399	7.6	55	3190
120	399	8.0	58	3740

TABLE 9

MYERS MODEL  
(Continued)

<u>Stand Age (Years)</u>	<u>Trees No.</u>	<u>Ave. DBH In.</u>	<u>Ave. Height Ft.</u>	<u>Total Volume Cu. Ft.</u>
20	2000	2.3	17	430
30	1827	2.9	22	820
40	1669	3.4	26	1260
50	1525	3.8	30	1690
60	1393	4.2	35	2140
70	1273	4.6	38	2620
80	1163	5.0	42	3110
90	1063	5.3	46	3470
100	971	5.6	49	3800
110	922	5.9	52	4270
120	871	6.2	55	4710

## CHAMPIONS MODEL

Beginning Age: 15  
 Rotation Age: 99  
 Soil Type: 5 (Blackleed Series)  
 Species: 4 (Lodgepole Pine)

Age of Alteration		Species	Alteration
20	Release	4	436 S
45	Thin	4	300 S
65	Thin	4	200 S

Species	Ave. DBH	Stems/Acre
4	1.300	1500

H - Total Height  
 SP - Species  
 D - Ave. DBH  
 S - Stems Per Acre

<u>AGE</u>	<u>SP</u>	<u>D</u>	<u>H</u>	<u>S</u>
20	4	1.982	1042	436
30	4	3.246	1042	423
45	4	4.687	184	300
65	4	5.264	83	200
80	4	7.360	83	191
99	4	8.583	181	0

CHAMPIONS MODEL  
(Continued)

Beginning Age: 15  
Rotation Age: 99  
Soil Type: 5  
Species: 4

Additional Listings: 30 40 50 60 70 80 90

Species	Ave. DBH	Stems/Acre
4	1.300	1500

H - Total Height  
SP - Species  
D - Ave. DBH  
S - Stems Per Acre

No Treatment

<u>AGE</u>	<u>SP</u>	<u>D</u>	<u>H</u>	<u>S</u>
30	4	3.003	0	1434
40	4	3.703	0	1391
50	4	4.228	0	1350
60				
70	4	5.005	0	1272
80	4	5.313	0	1234
90	4	5.588	0	1197
99	4	5.813	1165	0



CHAMPIONS MODEL  
(Continued)

Beginning Age: 15  
Rotation Age: 99  
Soil Type: 5  
Species: 4

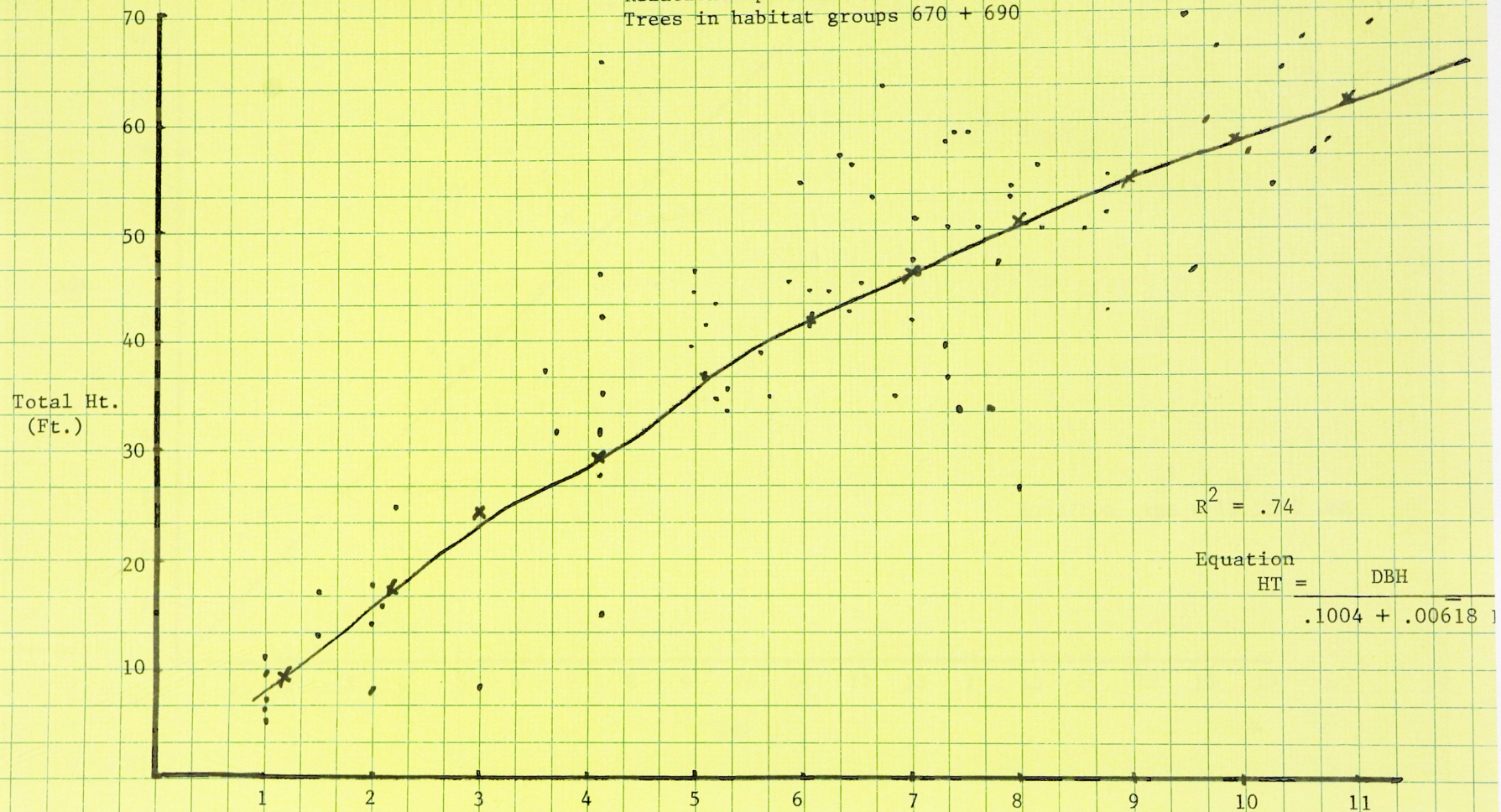
Age of Alteration	Species	Alteration
20 Release	4	436 S

Species	Ave. DBH	Stems/Acre
4	1.300	1500

H - Total Height  
SP - Species  
D - Ave. DBH  
S - Stems Per Acre

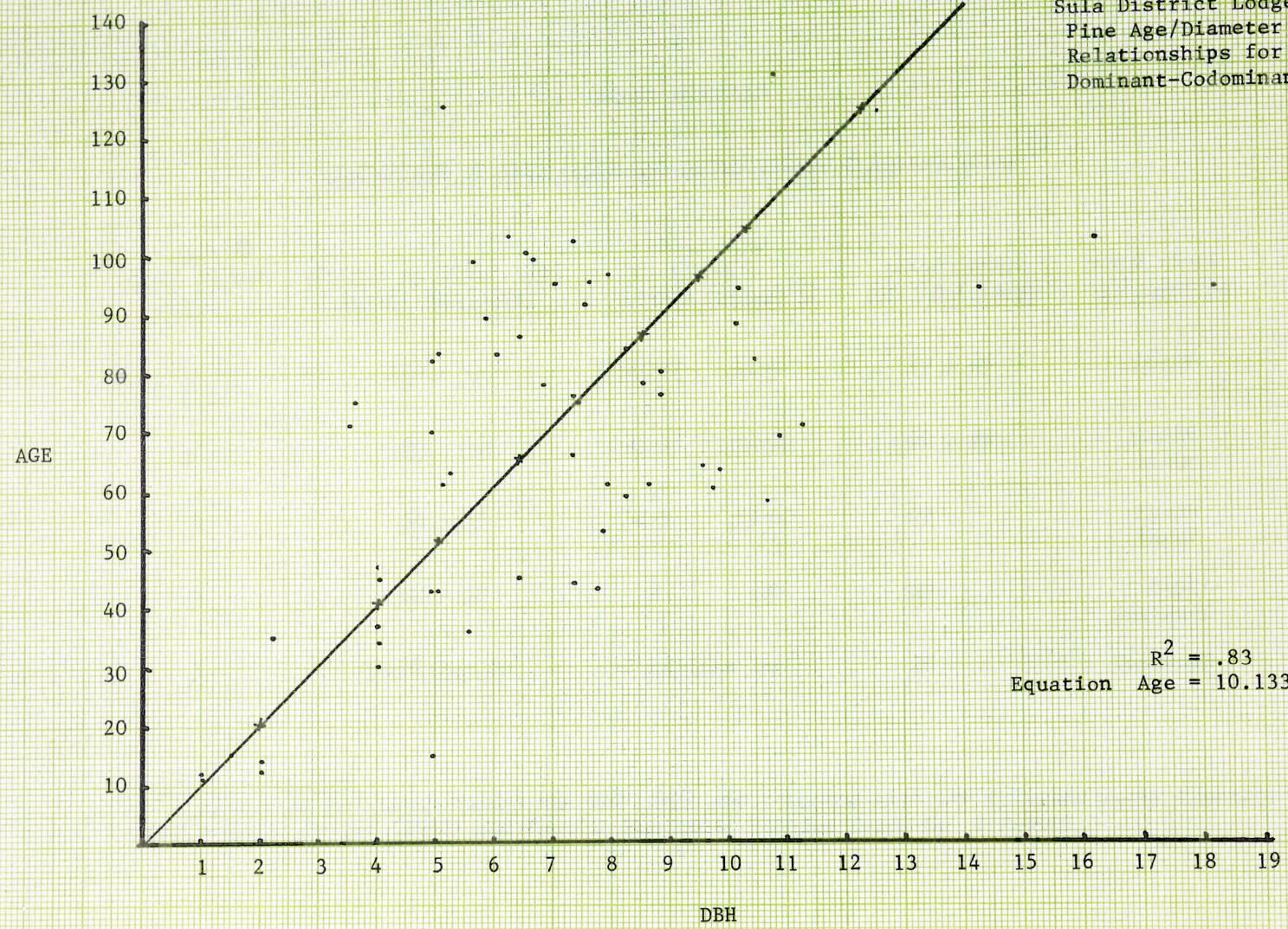
<u>AGE</u>	<u>SP</u>	<u>D</u>	<u>H</u>	<u>S</u>
20	4	1.982	1042	436
30	4	3.246	1042	423
40	4	4.252	1042	411
50	4	5.087	1042	398
60	4	5.803	1042	387
70	4	6.432	1042	375
80	4	6.995	1042	364
90	4	7.507	1042	353
99	4	7.932	344	0

Lodgepole Pine Ht/Diameter  
Relationships for dominant & codominant  
Trees in habitat groups 670 + 690





Sula District Lodgepole  
Pine Age/Diameter  
Relationships for  
Dominant-Codominant trees.



$R^2 = .83$   
Equation Age = 10.1335 DBH

BEEM



## STAND ANALYSIS

COMPARISON OF SITE INDEX AND PRODUCTIVITY CLASSIFICATION <sup>1/</sup>

<u>OMB Prod. Class Code</u>	<u>Potential Yield, MAI (Cu.Ft.Per/Acre)</u>	<u>Site Tree Growth (1/20") (Rings/")</u>		<u>Site Index (50 Year Base)</u>	<u>Prod. Size All Species</u>
1	120 - 165	19-22	11-9	70 & 80	18-20
2	85 - 120	14-18	14-11	50 & 60	14-20 16-LP
3	50 - 85	13-9	22-15	40	10-14 14-LP
4	20 - 50	8	25	30	8-10 Cordwood
5	less than 20	7 or less	26+	20	Cordwood

---

<sup>1/</sup>Based on R-1 Larch Guides FSH 2471.15R1 and compared with LPP Colorado Rocky Mountain Station Paper No. 26 (1967) and Pacific Northwest Station Paper No. 8 (1964).

## BITTERROOT

## TIMBER INVENTORY/FUEL INVENTORY

## LOADING

## TONS/ACRE

Habitat Type	N	$\frac{1}{4}$ -1	1-3	3+S&R	% Rot	Total Woody	Total For Floor	Total	(Inches) Duff Depth
AF/Mefe	81	1.311	2.191	36.826	30.781	40.388	20.884	61.272	1.643
AF/Vasc	45	.904	1.989	23.080	43.040	25.987	12.169	38.156	.960
AF/Xete	1073	1.060	2.402	25.311	45.255	28.844	13.210	42.854	1.007

SOIL PRODUCTIVITY

1. Soil Depth		
Grass within 12" of surface	0	
Soil less than 24"	10	10
Soil greater than 24"	30	
2. Texture		
A	5	5
B	10	
C	15	
A	20	
3. Coarse Fragment		
<25%	15	15
26-50%	5	
>50%	0	
4. Elevation - Aspect		
4000-5000 N	15	
5000-6200 N	25	
6200-7200 N	10	10
7200+ N	-10	
< 5000 S	0	
5000-6000 S	10	
6000-7000 S	15	
6700-7600 S	5	
7600+ S	-10	
5. Loess		
None	0	5
12"+	10	
6. Special Problems		
Restrictive rooting zone	-25	
Excessive stoniness 70% surface	-25	
Poor drainage	- 5	
Slope	-20	
		<hr/> 45

Soil Productivity Rating

0-10	Very Low	
15-25	Low	
30-45	Moderate	Moderate
50-65	High	
65+	Very High	

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